BEHAVIOUR OF LAST INSTAR *AUSTROLESTES PSYCHE* (SELYS) LARVAE (ODONATA: LESTIDAE)

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Abstract

The behaviour of single and paired last instar larvae of *Austrolestes psyche* (Selys) was analysed from videotape records, and the repertoires of postures and movements compared with those recorded for other Zygoptera. Thirteen distinct postures or motions were found, four of which did not occur in isolated larvae. Several elaborate body movements may be agonistic displays. 'Labial strike' is presumed to be aggressive and was commonly followed by the retreat response of swimming.

Introduction

The behavioural repertoire of larval damselflies (Odonata, Zygoptera) is sometimes substantial, but the functions of the various components are often difficult to interpret and there has been little sound descriptive work to document the behaviour in different taxa. All previous detailed work has been on Coenagrionidae. Abdominal movement has commonly been interpreted as ventilatory in function, enhancing the presumed primary function of the caudal lamellae but there is little experimental evidence for this (Rowe 1985). In the endemic New Zealand coenagrionid *Xanthocnemis zealandica* (McLachlan), abdominal movements are intraspecific displays rather than ventilatory movements (Rowe 1985). Agonistic displays occurred in larvae of several New Zealand Zygoptera studied by Rowe but the repertoire size varied between species. In *Pyrrhosoma nymphula* (Charp.) larvae actively defend feeding sites against intruders (Harvey and Corbet 1985). Further documentation of a range of taxa, especially non-Coenagrionidae, is needed to aid in interpreting the evolution of presumptive display behaviour in the Zygoptera. A study of *Ischnura verticalis* (Say) (McPeek and Crowley 1987) included functional analysis of some common behaviour of zygopteran larvae.

This note contains preliminary information on the behavioural repertoire of last instar larvae of *Austrolestes psyche* (Selys), an abundant Australian lestid. Larvae of this species, in common with those of some other Australian species of *Austrolestes* Tillyard, are normally associated with mud or vegetation in pools or lakes. The study material was collected from seasonally flooded heathland swamps on the northern part of Wilsons Promontory National Park, Victoria, where it was the most abundant zygopteran present. The habitats are described by Sant and New (1988) and larval diagnosis was aided by Hawking (1986).

Methods

Larvae were maintained individually at 25°C in 38 ml containers of water at pH 5 and 12:12 h light:dark photoperiod and with excess Cladocera and Copepoda as prey. Observations were made on larvae starved for 24 h immediately before use, and methods were based on those used by other workers (Baker 1980, Crowley 1979, Crowley *et al.* 1987, Rowe 1985). Last instar larvae, confirmed as such by rearing of adults from several larvae of similar size, of both sexes were observed in an aquarium partitioned to form a 14 x 12 x 20 cm study chamber with the walls marked with a reference grid to plot larval position. Water was maintained at 25°C and pH 5 and larvae were allowed to settle for 1 h before observations were commenced. A 1 h VHS videotape record was then taken at 25 frames/s. A 2 mm diameter wooden stem was then placed vertically in the tank to provide a central 'perch', and a further 1 h of larval settling was followed by another 1 h of tape observation. Similar series of trials were undertaken on single larvae and pairs of larvae and descriptions of behavioural movements and postures were prepared from the videotapes.

Results

(a) *Behavioural repertoire*

Thirteen distinct larval postures or motions were observed.

(i) Normal stance (NS) (Fig. 1). The larval body is held in parallel to the substrate with the lamellae spread. The larva is stationary.

(ii) NS walk. Walking in the normal stance posture.

(iii) Head down stance (HD) (Fig. 5). The larva stands with the head inclined downwards so that the antennae touch the substrate and the abdomen is raised so the spread lamellae are perpendicular to the substrate.

(iv) HD walk. Walking in the head down posture.

(v) (Fig. 2). A less pronounced form of the HD stance: the antennae touch the substrate but the abdomen is raised to about 45°.

(vi) (Fig. 3). A less pronounced form of (v): the head itself is on the substrate and the abdomen raised to about 20°.

(vii) (Fig. 4). A stance with the caudal lamellae resting on the substrate and the abdomen held rigid.

(viii) 'Pull-down' (Fig. 8, i-iii). The larva in NS lowers its head, then slowly raises the whole body by extending the legs fully. The body is then rapidly lowered close to the substrate and the abdomen slightly flexed as this occurs. The display lasts about 0.36 s.

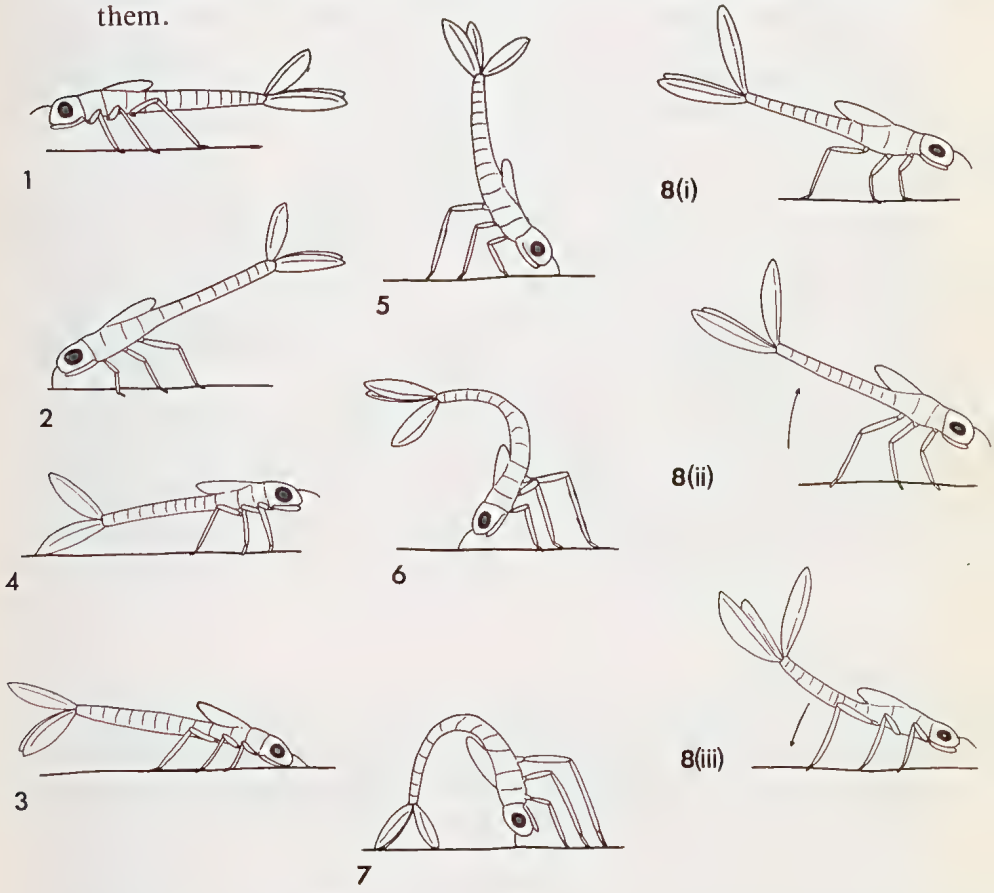
(ix) 'Forward bend' (FB) (Fig. 6). The larva in NS or HD stance raises the abdomen dorsally, extending the legs so that the antennae touch the substrate, the head and thorax are almost perpendicular and the abdomen almost parallel to the substrate.

(x) 'Forward arch' (FA) (Fig. 7). A more extreme form of FB with the abdomen arched dorsally so that the caudal lamellae touch the substrate in front of the insect, and the head and thorax are inclined beyond the perpendicular.

(xi) FA walk. Walking in the FA position.

(xii) Labial strike. The close proximity of two larvae sometimes led to one or both individuals rapidly extending the labial mask, as in normal prey capture. Such behaviour lasted up to 6 s and normally concluded by both larvae swimming away.

(xiii) Swimming. Involves sinuous movements of the abdomen for bursts of about 0.3 s, with rests of about half this time between them.



Figs 1-8. Postures and behaviour of *Austrolestes psyche* larvae, diagrammatic: (1) normal stance; (2) weak head down stance; (3) head-rest stance; (4) lamella-rest stance; (5) head down stance; (6) forward bend; (7) forward arch; (8) The 'pull-down' of *Austrolestes psyche* larvae - (i) - (iii) in sequence: the body is raised (ii) and then rapidly lowered (iii).

(b) *Incidence of major kinds of behaviour*

The behaviour exhibited by different larvae varied considerably: at the extremes, one larva remained motionless in normal stance and one in the head down stance for an hour, and another completed 774 pull-downs (sensu Eriksen 1986) in the same time. Pull-downs and forward arch occurred only in the presence of another larva. Indeed, the repertoire of paired larvae included most of the more elaborate displays enumerated above, but their incidence was too low for statistical analysis. Forward arch and forward arch walk, for example, occurred only in one of a single pair of individuals. Two forward arches together occupied 205 s, and the single ensuing walk, 7 s. Labial mask extension occurred in 5 individuals, involving 3 pairs of larvae. The other major response when larvae were placed together, swimming, was more common and occurred in all but one pair of larvae observed. Only 2 isolated larvae swam and it seemed to be a relatively uncommon mode of locomotion by single larvae.

The extents of swimming and of normal stance were significantly different between single and paired larvae. Both were more common in paired larvae but independent of the presence or absence of a perch (stem) (Kruskall-Wallis 1-way Anova, P assessed at 1% level). More paired larvae adopted the normal stance, commonly for longer periods, than solitary larvae, but tended to adopt other behaviour when approached by the other larva. Solitary larvae more commonly adopted the lamella-rest stance, possibly a more 'relaxed' posture than the normal stance. Other aspects of behaviour did not differ significantly between solitary and paired larvae. Although larvae would commonly perch on the stem with head downwards for extended periods, no behaviour additional to that seen by larvae on the tank floor or walls was observed.

Discussion

A display apparently very similar to the "pull-down" of *A. psyche* was observed in *A. colensonis* (White) (Rowe 1985, 1987). That display was also repeated, but only 10-20 times before the larva paused and, seemingly, induced other nearby larvae to display in a similar manner. This stimulus effect was not observed in *A. psyche*, but the display of *A. colensonis* is more elaborate in that the wing sheaths are also spread. *A. colensonis* larvae also struck at the legs of conspecifics (Rowe 1985). The strike of *A. psyche* was usually from too great a distance for contact, as in the coenagrionid *X. zealandica*. Labial strike in *Coenagrion resolutum* (Hagen) occurred most frequently when another larva was present and almost always led to the attacked individual swimming (Baker 1981). It was interpreted as an aggressive behaviour in *I. verticalis* (McPeek and Crowley 1987), and it is reasonable to consider such displays as labial strike and the rare forward arch, which were found only in larvae with another present,

as agonistic, and the common subsequent response of swimming by one or both larvae, as well as being a retreat movement, may indicate some form of 'spacing behaviour' or territoriality - a not uncommon phenomenon in Zygoptera (Baker 1981a, Corbet 1962, Crowley *et al.* 1987, Harvey and Corbet 1985, Rowe 1980, as examples). Although Rowe (1985) believed *A. colensonis* to be non-territorial, there is clearly conspecific recognition mediated by reciprocal display. This display seemed to deter close approach by other larvae and was interpreted by Rowe (1987) as an aid in maintaining a 'personal distance', and (at the very least) in avoiding cannibalism if followed, as in *A. psyche*, by an escape movement.

The repertoire of *A. psyche* is more restricted than that of *X. zealandica* and some striking displays of that species, such as the 'S-bend', 'abdomen arch down' and lateral 'slash' were not observed. The absence of lateral abdominal movements was unexpected but the repertoire of *A. colensonis* is also very limited. Rowe (1985) noted only the pull-down in this species so that the displays of *A. psyche* seem to be rather more diverse than *A. colensonis* and may reflect a greater dependence on maintaining larval territory or individual spacing. Solitary larvae of the North American *Lestes disjunctus* (Selys) do not stay near areas of food concentration and presence of other larvae did not reveal any agonistic interactions (Baker 1981b). The North American *Coenagrion resolutum* (Coenagrionidae) exhibits 14 different behaviours (Baker 1981a) but, again, shows abdominal lateral movements, sometimes pronounced. This species exhibits a dominance system rather than holding territory and both possibilities are still viable for *A. psyche.* It appears that at least some larval Lestidae may be at least as diverse as Coenagrionidae in their behaviour and, overall, show rather similar interactions despite the two lineages having been separated for a very long time.

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